

## FLOWERS AND INSECTS. XVIII.

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ACTÆA L.—*A. spicata* L. is a white pollen-flower with incomplete proterogyny, though Axell regarded it as homogamous. Dr. Buddeberg's observation at Nassau of the visits of *Byturus fumatus* F. (Dermestidæ) and *Forficula auricularia* L. (Orthoptera) hardly indicates more than partial investigation or unfavorable conditions (4).

ACTÆA ALBA Bigel.— This agrees with observations made on *A. spicata*, of which it has been regarded as a mere variety.

The plant is rather rare, in low rich woods, rising 4–5<sup>dm</sup> and bearing short racemes. The sepals fall when the flower opens. The numerous stamens and the stigma are white and are the most conspicuous parts, the slender petals being of little use. The ovary is surmounted by large two-lobed stigma, which is receptive before the anthers open. The stamens are turned to a more or less horizontal position, so that, after the anthers open, the insect visitors are likely to touch the stigma before being dusted with pollen. The flowers open almost simultaneously. The proterogyny is incomplete, nectar is wanting, and the insects abandon the flowers as soon as the pollen is gone.

From their white color, small size and nectarless condition, the flowers seem to depend upon the females of small species of Halictus, by which they are abundantly visited. The blooming season is from May 3 to 23, a plant found in bloom on June 20 seeming quite an exceptional case. On May 8 the following visitors were observed :

Bees — *Andrenidae* : (1) *Andrena* sp. ♀, c. p. ? ; (2) *Halictus pectoralis* Sm. ♀, c. p., ab.; (3) *H. zephyrus* Sm. ♀, c. p.; (4) *Augochlora confusa* Rob. ♀, f. p.

On the pollination of *Actæa* see :

(1) Axell, Om anordningarna för de fanerogama växternas befruktning 60, 104. 1869.—(2) Ricca, Osservazioni sulla fecondazione incrociata dei vegetali alpini e subalpini. Atti Soc. Ital. Sci. 13:254. 1871; 14:249. 1872. *A. spicata*, distinctly proterogynous. cit. by Delpino.—(3) Delpino, Ulteriori osservazioni II. 2:178. Atti Soc. Ital. Sci. 16:326. 1873. *A. spicata*, probably macrobiostigmatic.—(4) Müller, Weitere Beobachtungen 1:53. 1878.—(5) Kirchner, Beiträge zur Biologie der Blüten. Progr. 72 Jahresfeier Kgl. Württemb. landwirtschaftl. Akad. Hohenheim 18. 1890. *A. spicata*. (Just 18<sup>t</sup>:492).—(6) Kerner, Pflanzenleben 2:—. 1891. Oliver translation 2:183, 310. 1895. *A. spicata*, attractive stamens, etc.

LESPEDEZA PROCUMBENS Michx.—The flowers are bright purple, especially the vexillum. There is a white triangular mark at base of the latter forming a pathfinder. The stamens and pistil are protected by the keel, which at first returns to its position when depressed. The stigma strikes the visitor in advance of the anthers. The calyx and claw of the banner are short, so that a tongue 2–3<sup>mm</sup> long can exhaust the nectar.

The blooming season is Aug. 2–Sept. 21. On Aug. 14 and 15 the following visitors were observed:

Bees — *Apidae*: (1) *Megachile brevis* Say ♀, s. & c. p.; (2) *Ammobates illinoensis* Rob. ♂ ♀, s.; (3) *Calliopsis andreniformis* Sm. ♂ ♀, s.; *Andrenidae*: (4) *Halictus confusus* Sm. ♀, s. & c. p.; (5) *Augochlora confusa* Rob. ♀, s. & c. p.

Diptera — *Bombylidae*: (6) *Systoechus vulgaris* Lw., s.

Lepidoptera — *Rhopalocera*: (7) *Lycaena comyntas* Gdt., s.

LESPEDEZA RETICULATA Pers.—*L. Virginica* (L.) Britt.—The plants grow 3–4<sup>dm</sup> high, are very leafy and rather densely covered with rose-colored flowers. The flower is about 5<sup>mm</sup> long, the calyx tube about 2<sup>mm</sup>, and the claw of the banner about 1.5<sup>mm</sup>.

The blooming season is July 30–Sept. 14. On Aug. 22, 27, 29, 31, and Sept. 2, 4, 7 the following visitors were observed:

Bees — *Apidae*: (1) *Bombus americanorum* F. ♂ ♀, s. & c. p., freq.; (2) *Anthophora walshii* Cr. ♀, s.; (3) *Melissodes nivea* Rob. ♀, s. & c. p.; (4) *Megachile optiva* Cr. ♀, s. & c. p.; (5) *M. brevis* Say ♂ ♀, s. & c. p., ab.; (6) *M. latimanus* Say ♀, s.; (7) *Coelioxys totonaca* Cr. ♀, s.; (8) *Epeolus concavus* Cr. ♀, s.; (9) *E. lunatus* Say ♀, s.; (10) *Calliopsis andreniformis* Sm. ♂ ♀, s.; (11) *Panurginus compositarum* Rob. ♂, s.; *Andrenidae*: (12)

*Halictus ligatus* Say ♂, s.; (13) *Augochlora confusa* Rob. ♂, s.; (14) *A. similis* Rob. ♂, s.; (15) *Colletes americanus* Cr. ♂, s.

Lepidoptera — *Rhopalocera*: (16) *Lycaena comyntas* Gdt., freq.; (17) *Thecla melinus* Hbn.; (18) *Colias philodice* Gdt.; (19) *Pamphila cernes* Edw.—all s.

**LESPEDEZA CAPITATA** Michx.—The flowers are white, pink streaks on the base of the banner forming pathfinders. The wings and keel are depressed together and return to their position covering the stamens and pistil. The claw of the banner is so long that a proboscis 3–4<sup>mm</sup> long is needed to reach the nectar. Its infolded edges guide the bee's tongue to the opening in the stamen tube.

The blooming season is Aug. 14–Sept. 11. On Aug. 14 and 23 I saw the flowers visited by two bees: *Megachile brevis* Say ♀, s. & c. p., and *Calliopsis andreniformis* Sm. ♂, s.

On the pollination of *Lespedeza* see:

(1) Berkeley, Sterility — constitutional and organic. *Gardener's Chronicle* 1: 36. 1855. Cleistogamy, both kinds of flowers simultaneous. Cit. by Henslow.—(2) Kuhn, Einige Beobachtungen über *Vandellia* und den Blütenpolymorphismus. *Bot. Zeit.* 25: 67. 1867.—(3) Axell, Om anordningarna för de fanerogama växternas befruktning 11. 1869. Cites Kuhn.—(4) Henslow, On the self-fertilization of plants. *Trans. Linn. Soc. II. Bot.* 1: 327. (1877) 1880.—(5) Foerste, Notes on structures adapted to cross-fertilization. *Bot. Gaz.* 13: 152. 1888. *L. violacea* (Just 16<sup>1</sup>: 533).

**CORNUS** L.—The flowers are perfect. According to Gray's *Manual* some foreign species are dioecious. In the Tyrol Schulz (12) failed to verify the observation of Hausmann that *C. Mas* is dioecious or polygamous. From the condition of certain examples of *C. Canadensis* after flowering Meehan (14) inferred that this species is monoecious and dioecious.

The flowers have four petals, four stamens, a single style with terminal or capitate stigma, the base of the style being surrounded by an epigynous nectar disk.

One group of *Cornus* consists of species whose flower clusters are surrounded by an involucre, which is usually white. In these the petals are less conspicuous, and, at least in some cases, less expanded, so that they limit access to the nectar.

In the other group the conspicuousness of the inflorescence depends upon the individual flowers, whose petals are white and widely expanded. The nectar is therefore freely exposed.

The flowers are homogamous. In *C. sanguinea* Müller (4, 8) observed that insects may effect cross or self-pollination, and in their absence that spontaneous self-pollination or geitonogamy may occur.

Sprengel (1) observed that *C. sanguinea* was visited by a variety of insects. Müller's list shows fourteen beetles, five flies and one Pompilus. Delpino (3) includes this species in his "Tipo idrangeino," which he regards as adapted to beetles.

CORNUS FLORIDA L.—Kerner (13) supposes that the bracts serve as attractive organs and as landing places for insects. But insects visiting the flowers seldom alight on them. He also mentions what he calls "arrangements for geitonogamy," which seem to me to be quite imaginary.

This small tree occurs in only one place in my neighborhood. A dozen or more flowers are collected in a head. The four scales of the hibernaculum, which encloses the developing head, greatly elongate and expand at base, at the same time assuming a white or pinkish color. Very frequently the two inner scales remain united, so that by their basal expansion they form an arch over the head. These parts are often folded inwards in the middle, with the result that the head is often more conspicuous laterally than would be the case if all of the scales were expanded horizontally.

Nectar is secreted by an epigynous disk. The calyx tube is about 1<sup>mm</sup> deep. This with the four petals and four filaments has the effect of concealing the nectar in a tube about 2<sup>mm</sup> deep.

The petals are greenish yellow, their tips being reflexed, the flower expanding about 4<sup>mm</sup>. The stamens are strongly divergent and are exerted about 4<sup>mm</sup>, the style projecting little more than 1<sup>mm</sup>.

The flowers are homogamous. Insects crawling about over the inflorescence get their heads and undersides covered with pollen. On sucking they easily effect pollination. In their

absence spontaneous self-pollination or geitonogamy may sometimes occur by the pollen falling upon the stigmas. In *Cornus* and *Viburnum* the elongation and strong divergence of the stamens is no kind of an "arrangement for geitonogamy," though it may result in that, but merely places the anthers in position to strike insects which run about irregularly over the flowers.

The flowers were noted in bloom from April 22 to May 8. In this time very few of the lower aculeate Hymenoptera are flying. The following list, observed on April 23, showing a strong preponderance of Andrenidae, with flies less abundant, is about what might be expected from the structure of the flowers and the composition of the insect-fauna at the blooming time:

Hymenoptera—*Apidae*: (1) *Bombus separatus* Cr. ♀, s., one; (2) *Osmia albiventris* Cr. ♀, s. & c. p., one; (3) *Nomada sayi* Rob. ♂, s.; *Andrenidae*: (4) *Halictus foxii* Rob. ♀, s. & c. p.; (5) *H. coriaceus* Sm. ♀, s.; (6) *H. fasciatus* Nyl. ♀, s. & c. p., freq.; (7) *H. pilosus* Sm. ♀, s. & c. p.; (8) *H. zephyrus* Sm. ♀, s.; (9) *H. confusus* Sm. ♀, s.; (10) *H. obscurus* Rob. ♀, s. & c. p.; (11) *H. stultus* Cr. ♀, s. & c. p., freq.; (12) *Agapostemon radiatus* Say ♀, s.; (13) *Augochlora pura* Say ♀, s. & c. p.; (14) *A. confusa* Rob. ♀, s. & c. p.; (15) *Andrena vicina* Sm. ♀, s.; (16) *A. bipunctata* Cr. ♂ ♀, s. & c. p., freq.; (17) *A. rugosa* Rob. ♂ ♀, s.; (18) *A. claytoniae* Rob. ♀, s. & c. p., freq.; *Vespidae*: (19) *Polistes metricus* Say, s.; *Eumenidae*: (20) *Odynerus foraminatus* Sauss., s., one.

Diptera—*Empididae*: (21) *Empis humilis* Coq., freq.; *Bombylidae*: (22) *Bombylius pulchellus* Lw.; (23) *B. major* L.; *Syrphidae*: (24) *Chilosia capillata* Lw.; (25) *Mesograpta marginata* Say; (26) *Criorhina umbratilis* Will.; *Lonchaeidae*: (27) *Lonchaea polita* Say—all s.

Lepidoptera—*Rhopalocera*: (28) *Nisoniades juvenalis* F., s.

Coleoptera—*Cerambycidae*: (29) *Molorchus bimaculatus* Say, s. & f. p.

*CORNUS PANICULATA* L'Her.—*C. candidissima* Marsh.—In his classification of floral types Delpino (3) places this species in his "Tipo idrangeino," which, as stated above, he regards as adapted to beetles. He considers the scent of the flowers, which he calls "odore carabico o scarabeo," as further indicating an adaptation to these insects. He saw the flowers abundantly visited by *Cetonia aurata* and other Coleoptera.

The shrubs are much branched, rise from 1 to 3<sup>m</sup> high and

bear numerous flat or convex cymes of white flowers. The cymes expand from 4 to 5<sup>cm</sup>.

The four petals are horizontally expanded to the extent of about 1<sup>cm</sup>. The stigma rises to about the level of the anthers. Nectar is secreted by a yellow epigynous disk and is completely exposed.

The flowers are homogamous. Spontaneous self-pollination is usually prevented by the stamens being strongly divergent. Insects crawl about over the clusters and become thoroughly dusted with pollen. Pollination occurs between separate flowers of the same or distinct plants.

*C. paniculata* having completely exposed nectar is adapted to a more miscellaneous set of insects than *C. florida*, which has nectar more concealed. Nevertheless, the list of visitors of the former differs from that of the latter mainly in showing more insects of the same kind, it being a larger list. The list of *C. paniculata* shows twenty-one species of lower Aculeata and Tachinidae, only three of which are flying when *C. florida* is in bloom.

The blooming season is May 12–June 13. The following list was observed on May 12, 18, 23, 29, and June 8:

Hymenoptera—*Apidae*: (1) *Apis mellifica* L. ♀, s. & c. p., freq.; (2) *Bombus americanorum* F. ♀, c. p.; (3) *Synhalonia frater* Cr. ♀, c. p.; (4) *Ceratina dupla* Say ♀, s. & c. p.; *Andrenidae*: (5) *Halictus pectoralis* Sm. ♀, s. & c. p.; (6) *H. pilosus* Sm. ♀, s.; (7) *H. confusus* Sm. ♀, s. & c. p., freq.; (8) *H. tegularis* Rob. ♀, s., freq.; (9) *H. stultus* Cr. ♀, s. & c. p.; (10) *Agapostemon radiatus* Say ♀, s. & c. p.; (11) *A. viridulus* F. ♀, s. & c. p.; (12) *Augochlora confusa* Rob. ♀, s. & c. p.; (13) *A. similis* Rob. ♀, s.; (14) *Andrena vicina* Sm. ♀, s.; (15) *A. sayi* Rob. ♀, s. & c. p.; (16) *A. pruni* Rob. ♀, s.; (17) *A. platyparia* Rob. ♂ ♀, s. & c. p., ab.; (18) *A. cressonii* Rob. ♀, s. & c. p.; (19) *A. rugosa* Rob. ♀, s. & c. p.; (20) *A. forbesii* Rob. ♀, s.; (21) *A. hippotes* Rob. ♀, s.; (22) *A. claytoniae* Rob. ♀, s. & c. p., freq.; (23) *Prosopis pygmaea* Cr. ♂, s.; (24) *P. modesta* Say ♂ ♀, s.; (25) *P. affinis* Sm. ♂, s.; *Eumenidae*: (26) *Eumenes fraternus* Say; (27) *Monobia 4-dens* L.; (28) *Odynerus* sp.; (29) *O. campestris* Sauss.; (30) *O. unifasciatus* Sauss.; (31) *O. foraminatus* Sauss.; *Crabronidae*: (32) *Crabro interruptus* Lep., freq.; (33) *C. errans* Fox; (34) *Oxybelus emarginatus* Say; *Sphécidae*: (35) *Pelopoeus cementarius* Dru.; (36) *Chalybion caeruleum* L.; *Pompilidae*: (37) *Ceropales fulvipes* Cr.; *Chalcididae*: (38) *Smicra torvina* Cr.—all s.

Diptera—*Empididae*: (39) *Empis levicula* Coq.; (40) *E. clausa* Coq.; (41) *E. distans* Lw.; *Conopidae*: (42) *Oncomyia loraria* Lw.; *Syrphidae*: (43) *Pipiza pulchella* Will.; (44) *Chrysogaster nitida* F., freq.; (45) *Syrphus americanus* Wd.; (46) *Eristalis aeneus* F.; (47) *E. transversus* Wd.; (48) *E. dimidiatus* Wd.; (49) *Mallota cimbiciformis* Fll.; *Tachinidae*: (50) *Alophora purpurascens* Twms.; (51) *Jurinia apicifera* Wlk., freq.; (52) *J. smaragdina* Mcq.; (53) *Belvosia bifasciata* F.; (54) *Phorocera edwardsii* Will., freq.; (55) *Acroglossa hesperidarum* Will.; (56) *Frontina flavicauda* Riley; (57) *Atrophopoda singularis* Twms.; (58) *Chaetophleps setosa* Coq.; *Sarcophagidae*: (59) *Sarcophaga* sp.; (60) *Helicobia helcis* Twms.; *Muscidae*: (61) *Lucilia* sp.; (62) *L. sericata* Mg.; (63) *Graphomyia americana* R. D.; (64) *Morellia micans* Mcq.; *Anthomyidae*: (65) *Anthomyia marginata* Wlk.; (66) *Phorbia acra* Wlk.; *Ortalidae*: (67) *Camptoneura picta* F.—all s.

Coleoptera—*Lampyridae*: (68) *Podabrus tomentosus* Say, freq.; (69) *Telephorus flavipes* Lec., freq.; *Scarabaeidae*: (70) *Euphoria fulgida* F.; (71) *Trichius piger* F., freq.; (72) *T. affinis* Gory, in cop.; *Cerambycidae*: (73) *Strangalia famelica* Newm.; *Mordellidae*: (74) *Pentaria trifasciata* Melsh.; (75) *Mordella marginata* Melsh.—all s. or f. p.

Lepidoptera—*Rhopalocera*: (76) *Pyrameis atalanta* L.; (77) *Papilio ajax* L.—both s.

On the pollination of *Cornus* see:

- (1) Sprengel, Das entdeckte Geheimniss 31, 33, 85. 1793. *C. mascula, sanguinea, florida*.—(2) Axell, Om anordningarna för de fanerogama växternas befruktning 103. 1869. *C. Suecica*.—(3) Delpino, Ulteriori osservazioni II. 2: 13, 39, 46, 52, 215, 237-8, 311. Atti Soc. Ital. Sci. 16: 161, 187, 194, 200. 1873; 17:—. 1874. *C. florida, Suecica, paniculata, sanguinea*.—(4) Müller, Befruchtung der Blumen 96. 1873. Fertilization of flowers 287. 1883. *C. sanguinea*.—(5) Lubbock, British wild flowers in relation to insects 107. 1875. *C. Suecica, sanguinea*.—(6) Bonnier, Les nectaires. Ann. Sci. Nat. Bot. VI. 8: 37, 40, 71, 135. 1878. *C. Mas, sanguinea*. (Just 7<sup>t</sup>: 120).—(7) Errera et Gevaert, Sur la structure et les modes de fécondation des fleurs. Bull. Soc. Bot. Belgique 17: 79. 1878. *C. sanguinea*.—(8) Müller, Weitere Beobachtungen 1: 31. 1878. *C. sanguinea*.—(9) Patton, Observations on the genus *Macropis*. Am. Journ. Sci. & Arts III. 18: 211-14. 1879. *C. paniculata*. (Just 7<sup>t</sup>: 145).—(10) Jordan, Stellung der Honigbehälter und der Befruchtungswerkzeuge in den Blumen 18. 1886. *C. sanguinea*.—(11) Kirchner, Flora von Stuttgart und Umgebung 399. 1888. *C. sanguinea*.—(12) Schulz, Bestäubungseinrichtungen und Geschlechtsvertheilung bei den Pflanzen 2: 191. 1890. *C. Mas*.—(13) Kerner, Pflanzenleben 2:—. 1891; Oliver translation 2: 173, 183-4, 200, 231, 296, 289, 326. 1895. *C. florida, Mas, sanguinea, Suecica*.—(14) Meehan, Contributions to the life-histories of plants VIII. Proc. Acad. Sci. Phil. 1892: 376. *C. Canadensis, florida*. (Bot.

Centralb. 61:263).—(15) MacLeod, Bevruchting der bloemen van Vlaanderen. Bot. Jaarboek 6:256, 437. 1894. *C. sanguinea*, Mas.—(16) Loew, Blütenbiologische Floristik 248. 1894. *C. sanguinea*, Mas.

VIBURNUM PUBESCENS Pursh.—The mode of pollination of this species, along with a general account of the genus and an index to the literature, has been given in Trans. Acad. Sci. St. Louis 7:170-2. The list of visitors recorded there, indicating a preponderance of beetles, is fragmentary and quite misleading. Beetles are more abundant on the old flowers, of which they eat all parts. The most frequent and efficient pollinators are the less specialized bees, and flies. The blooming season is May 2-25. The following list, observed on May 4, 5, 7 and 9, includes visitors previously mentioned. It shows an interesting assemblage of Empididae, a family of flies which reaches its maximum in May.

Bees—*Apidae*: (1) *Bombus americanorum* F. ♀, s.; (2) *B. separatus* Cr. ♀, s.; (3) *Synhalonia frater* Cr. ♂, s.; (4) *Ceratina dupla* Say ♀, s. & c. p.; (5) *Osmia albiventris* Cr. ♀, s.; *Andrenidae*: (6) *Halictus pectoralis* Sm. ♀, s. & c. p., freq.; (7) *H. foxii* Rob. ♀, s. & c. p.; (8) *H. 4-maculatus* Rob. ♀, s.; (9) *H. coriaceus* Sm. ♀, s.; (10) *H. cressonii* Rob. ♀, s. & c. p.; (11) *H. confusus* Sm. ♀, s. & c. p.; (12) *Augochlora confusa* Rob. ♀, s. & c. p.; (13) *Andrena vicina* Sm. ♀, s. & c. p.; (14) *A. sayi* Rob. ♀, s. & c. p., freq.; (15) *A. robertsonii* D. T. ♀, s. & c. p., freq.; (16) *A. mandibularis* Rob. ♀, s. & c. p., freq.; (17) *A. illinoensis* Rob. ♀, s.; (18) *A. cressonii* Rob. ♂ ♀, s. & c. p., ab.; (19) *A. personata* Rob. ♂, s. freq.; (20) *A. nuda* Rob. ♀, s. & c. p.; (21) *A. rugosa* Rob. ♀, s. & c. p., freq.; (22) *A. forbesii* Rob. ♀, s. & c. p.; (23) *A. claytoniae* Rob. ♀, s. & c. p., ab.; (24) *Prosopis affinis* Sm. ♂, s.; (25) *P. modesta* Say, ♀, s.; (26) *P. pygmaea* Cr. ♀, s.

Diptera—*Conopidae*: (27) *Myopa vesiculosa* Say; *Empididae*: (28) *Empis compta* Coq.; (29) *E. distans* Lw., freq.; (30) *E. humilis* Coq., freq.; (31) *E. avida* Coq.; (32) *E. nuda* Lw.; (33) *E. levicula* Coq.; (34) *E. otiosa* Coq.; (35) *Pachymeria pudica* Lw., freq.; (36) *Rhamphomyia priapulus* Lw., freq.; (37) *R. exigua* Lw.; (38) *R. sordida* Lw.; (39) *R. angustipennis* Lw.; (40) *R. mutabilis* Lw.; *Syrphidae*: (41) *Chilosia capillata* Lw.; (42) *Mesograpta geminata* Say; (43) *Volucella vesiculosa* F.; (44) *Criorhina umbratilis* Will., freq.; (45) *C. decora* Mcq.; (46) *Xylota chalybea* Wd.; (47) *Syrpita pipiens* L.; *Tachinidae*: (48) *Siphona illinoensis* Twns., freq.; (49) *Siphophyta floridensis* Twns.; *Muscidae*: (50, 51) *Lucilia* spp.; *Oscinidae*: (52) *Chloropa proxima* Say; (53) *Hippelates plebejus* Lw.—all s.

Coleoptera—*Dermestidae*: (54) *Anthrenus musaeorum* L., freq.; (55)



*Cryptorhopalum triste* Lec.; (56) *Orphilus glabratus* F., ab.; *Lampyridae*: (57) *Telephorus dentiger* Lec.; *Scarabaeidae*: (58) *Hoplia trifasciata* Say, freq.; (59) *Euphoria fulgida* F.; (60) *Valgus canaliculatus* F., gn.; *Cerambycidae*: (61) *Molorchus bimaculatus* Say, s., ab.; (62) *Callimoxys sanguinicornis* Oliv.; (63) *Euderces picipes* F.; *Chrysomelidae*: (64) *Diabrotica vittata* F., s.; (65) *Disonycha limbicollis* Lec., s.; (66) *Pachybrachys* sp., s.; *Bruchidae*: (67) *Bruchus hibisci* Oliv., s.; *Oedemeridae*: (68) *Asclera ruficollis* Say, s.; *Mordellidae*: (69) *Mordellistena biplagiata* Hel., freq.; (70) *M. aspersa* Mels., freq.; (71) *M. grammica* Lec.—all s., f. p., or gn.

Lepidoptera — *Rhopalocera*: (72) *Papilio ajax* L.; (73) *Nisoniades juvenalis* F.—both s.

*VIBURNUM PRUNIFOLIUM* L.—This is a small tree bearing numerous flat compound cymes of white flowers. The corolla expands 8–9<sup>mm</sup>, its base forming a short tube, which is somewhat obstructed by the short, thick style. The five stamens are strongly exerted, while the stigma is included in the tube. Nectar is secreted by a ring surrounding the base of the style. The flowers are homogamous. Cross-pollination by insects is assured, but self-pollination and geitonogamy may sometimes occur by the pollen falling upon the stigmas.

The blooming season is April 23–May 16. The following list was observed on April 24, 25, and 29:

Hymenoptera — *Apidae*: (1) *Apis mellifica* L. ♀, s. & c. p.; (2) *Synhalonia frater* Cr. ♂ ♀, s.; (3) *Ceratina dupla* Say, ♂, s.; (4) *Osmia lignaria* Say ♀, s.; (5) *O. albiventris* Cr. ♀, s.; (6) *Nomada sayi* Rob. ♂ ♀, s., freq.; *N. cressonii* Rob. ♂, s. freq.; (8) *N. maculata* Cr. ♂, s.; (9) *N. obliterated* Cr. ♂, s.; *Andrenidae*: (10) *Halictus foxii* Rob. ♀, s. & c. p.; (11) *H. pectoralis* Sm. ♀, s. & c. p. ab.; (12) *H. lerouxii* Lep. ♀ s. & c. p.; (13) *H. cressonii* Rob. ♀, s.; (14) *H. pilosus* Sm. ♀, s. & c. p.; (15) *H. tegularis* Rob. ♀, s. & c. p.; (16) *H. confusus* Sm. ♀, s. & c. p., ab.; (17) *H. stultus* Cr. ♀, s. & c. p., ab.; (18) *Agapostemon radiatus* Say, ♀, s.; (19) *Augochlora confusa* Rob. ♀, s. & c. p., freq.; (20) *Sphecodes ranunculi* Rob. ♀, s.; (21) *S. dichrous* Sm. ♀, s., freq.; (22) *S. mandibularis* Cr. ♀, s.; (23) *S. stygius* Rob. ♀, s.; (24) *Andrena vicina* Sm. ♀, s.; (25) *A. pruni* Rob. ♂ ♀, s. & c. p., in cop.; (26) *A. sayi* Rob. ♂ ♀, s. & c. p., freq.; (27) *A. erythrogastra* Ashm. ♂, s.; (28) *A. cressonii* Rob. ♂ ♀, s. & c. p., freq.; (29) *A. bipunctata* Cr. ♂ ♀, s. & c. p., ab.; (30) *A. personata* Rob. ♂ ♀, s., ab. (31) *A. claytoniae* Rob. ♀, s. & c. p.; (32) *A. forbesii* Rob. ♀, s.; (33) *A. hippotes* Rob. ♀, s. & c. p.; (34) *A. mariae* Rob. ♀, s.; (35) *Colletes inaequalis* Say ♂; *Vespididae*: (36) *Polistes metricus* Say, s.; *Eumenidae*: (37) *Odynerus tigris* Sauss., s.

Diptera—*Stratiomyidae*: (38) *Stratiomyia quaternaria* Lw., s., freq.; *Empididae*: (39) *Empis otiosa* Coq., s., freq.; (40) *Rhamphomyia priapulus* Lw., s.; *Bombylidae*: (41) *Bombylius major* L., s.; (42) *B. pulchellus* Lw., s.; *Conopidae*: (43) *Myopa vesiculosa* Say, s., freq., in cop.; *Syrphidae*: (44) *Paragus bicolor* F.; (45) *Psilota buccata* Mcq.; (46) *Chrysogaster pictipennis* Will.; (47) *Chilosia* sp.; (48) *C. capillata*, Lw., freq.; (49) *C. versipellis* Will., freq.; (50) *Mesograpta marginata* Say; (51) *M. geminata* Say; (52) *Myiolepta strigillata* Lw., freq.; (53) *Brachyopa vacua* O. S.; (54) *Eristalis aeneus* F., freq.; (55) *E. dimidiatus* Wd.; (56) *E. transversus* Wd.; (57) *Helophilus latifrons* Lw.; (58) *Criorhina umbratilis* Will.; (59) *C. decora* Mcq.; (60) *Syritta pipiens* L.; *Tachinidae*: (61) *Gymnosoma fulginosa* R. D.; (62) *Jurinia apicifera* Wlk.; (63) *Peleteria robusta* Wd., freq.; (64) *Gonia frontosa* Say; *Muscidae*: (65) *Graphomyia americana* R. D.; (66) *Lucilia* sp.; (67) *L. caesar* L.; (68) *L. cornicina* F.; (69) *L. latifrons* Schin., freq.—all s. or f. p.

Lepidoptera—*Rhopalocera*: (70) *Pyrameis huntera* F.; (71) *Phyciodes nycteis* Db.-Hew.; (72) *Thecla melinus* Hbn.; (73) *Lycaena pseudargiolus* Bd.-Lec.; (74) *Nysoniades juvenalis* F., freq.; (75) *N. martialis* Scud.; *Sphingidae*: (76) *Hemaris thysbe* F.—all s.

LONICERA L.—The flowers of honeysuckles present quite a variety of forms and adaptations. In the case of zygomorphous flowers in general, except those like *Heracleum*, I have advanced the proposition<sup>†</sup> that the flowers were originally adapted to bees, or principally visited by them. Correlated with this is the proposition that hawk moths and humming birds, from the fact that they do not alight upon the flower, do not have any influence in producing irregularity, and that the irregular flowers which are adapted to them were monopolized by them after they had been changed to an irregular form by bees. I assume that the flowers have become sternotribe from the fact that bees have been in the habit of landing upon the stamens and style. While the hawk moths do not tend to produce irregular flowers, it does not follow that their influence is to turn such flowers back to a more regular form, for the limitation of the pollen contact to the undersides of their bodies is clearly advantageous to the flowers. I suppose then, that the irregular sphingophilous species were originally bumble-bee flowers which have been usurped and further modified by hawk moths. The bumble-bee

<sup>†</sup> Zygomorphy and its causes. BOT. GAZ. 13: 229. 1888.

flowers may have come from the short-tube forms, which were adapted to the less specialized bees or to wasps. Or, the wasp-flowers may have come from those adapted to bumble-bees by a process of retrograde metamorphosis, as in the case of *Scrophularia*. If the bird-flower, *L. sempervirens*, came from an irregular form, I do not understand how it has lost it. However, the more regular form has the effect of lengthening the tube and of excluding the intruders which might remove the pollen.

The irregular flowers have four lobes above forming a vexillum—one of the many cases Henslow's theory will not account for—and a single lobe below, which projects forwards and assists in supporting the visitor, or is reflexed.

The flowers of most species are more or less horizontal, and this is the typical position, if my theory is correct. Some are nearly erect and others pendulous.

The corolla tube varies in length from 7<sup>cm</sup> in *L. longiflora* (Delpino 7) to 3-4<sup>mm</sup> in *L. xylosteum* (Müller 5). The long-tubed species are adapted to hawk moths, those of mid-length to bumble-bees, while the short-tubed species are adapted to the smaller bees, or even in one case to wasps, as *L. alpigena* (Müller 14). The last case is questioned by Schulz (29). MacLeod and others have been so confused by observing the frequent visits of bees to wasp-flowers that they have been inclined to abandon that category. But the wasp-flowers always show a proportion of wasps that is not equaled in any other flowers.

The usual color appears to be yellowish, the old flowers inclining to turn purplish, or white with rosy or purplish tints. The sphingophilous species are commonly whitish, the ornithophilous *L. sempervirens* red, as in all of our bird-flowers—*Tecoma radicans*, *Aquilegia Canadensis*, *Lobelia cardinalis*, *Castilleja coccinea*—while *L. alpigena* is reddish brown, as in *Scrophularia*.

The sphingophilous species open at night and emit a strong scent at that time, but the ornithophilous *L. sempervirens* is said by Hancock<sup>2</sup> (34) to be scentless.

<sup>2</sup>This author has a good deal to say about certain wonderful pollen-holding structures on the head of *Trochilus colubris*. Unfortunately, they are in the wrong

According to Kerner (31), in the twining honeysuckles (*L. caprifolium*, *etrusca*, *grata*, *implexa*, *periclymenum*, etc.) nectar is secreted in the lowest part of the tube, while in the non-twining ones (*L. alpigena*, *nigra*, *xylosteum*, etc.) it is secreted in an expansion above the base. In the sphingophilous species the nectar is protected from unbidden guests by the long, narrow tube; in the shorter, wider tubed species it is protected by hairs upon the filaments and the inner wall of the corolla. Under conditions unfavorable for the visits of hawk moths, nectar accumulates in the long-tubed species until a part of it becomes accessible to some long-tongued intruders.

Some observers have found in the tubes holes which, they imagined, were made by bees. Müller saw *L. coerulea* perforated by *Bombus mastrucatus*. Schneck (27) saw *Megachile brevis* (?) cutting circular pieces out of the tubes of *L. sempervirens*, as he says, to obtain the nectar. I have seen this bee cut such pieces out of the corollas of *Ænothera fruticosa*, *Cassia Chamaecrista* and *Ruellia ciliosa*, but she carried them away to use in her nests.

The anthers are exposed so that the pollen is accessible to a number of intruders, principally *Andrenidae* and *Syrphidae*, which may collect it or feed upon it, usually doing harm, though they may sometimes effect cross- or self-pollination. Meehan (22, etc.), who has observed only this kind of insect visits to a cultivated exotic species, concludes from it that the presence of nectar is of no significance as an adaptation for insect pollination.

The statements in regard to dichogamy, or other adaptations for cross-pollination, are remarkably conflicting. *L. caprifolium* is homogamous according to Müller (5), slightly proterogynous according to Kirchner (28). *L. xylosteum* is homogamous (Müller) and proterogynous with spontaneous alternating movements of stamens and style (Kerner). *L. coerulea* is proterogynous (Hildebrand 2, Ricca 4) and homogamous (Müller 15). Müller calls *L. periclymenum* homogamous, and supposes that cross-pollination is favored by the stigma being in advance of place, for all of our bird-flowers whose ranges approach that of the ruby-throat, with the exception of *A. Canadensis*, strike the bird on the upper side. The case is imaginary, anyhow.



The preceding table gives the insect visitors of *Lonicera* as observed in different regions.

*LONICERA SULLIVANTII* Gray.—This honeysuckle occurs in two places in my neighborhood, on creek banks. The flowers are in clusters at the ends of the branches and hold a more or less horizontal position. Newly opened ones are rather pale yellow, but later show a purplish tinge. The upper lip consists of four lobes which are turned up like a vexillum; the lower consists of a single lobe. Bees land upon the stamens and style, which are exerted about 7<sup>mm</sup>. The corolla tube measures 14–18<sup>mm</sup> in length. Nectar is secreted and retained in a slight gibbosity near the base of the tube.

The flowers are homogamous, the stigmas are receptive a little before the opening of the anthers, but the proterogyny is too slight to be of much importance. The stigma is somewhat in advance of the anthers, but not enough always to prevent spontaneous self-pollination.

I have observed flowers opening as early as 4 o'clock in the afternoon, the anthers beginning to open at 5:15 o'clock, and most of the flowers shedding pollen by 5:30. These flowers were visited by *Bombus virginicus* Oliv. ♀, three; *Anthophora ursina* Cr. ♀ and the humming bird, *Trochilus colubris* L., so that there was abundant opportunity for them to be effectually pollinated before sundown. The work of pollination may be completed by hawk moths in the evening, or when the bees and humming birds return next morning.

The blooming season is short; May 15–June 6. I have seen the flowers visited in the morning by:

Bees: (1) *Bombus virginicus* Oliv. ♀, s., freq.; (2) *B. americanorum* F. & S.; (3) *Anthophora ursina* Cr. ♀, s. & c. p., freq.

Birds: (4) *Trochilus colubris* L., s., freq.

Flies—*Syrphidae*: (5) *Pipiza femoralis* Lw., f. p., one.

On the pollination of *Lonicera* see:

(1) Sprengel, Das entdeckte Geheimniss 120. 1793. *L. xylosteum, caprifolium*.—(2) Hildebrand, Geschlechter-vertheilung bei den Pflanzen 18. 1867. *L. coerulea*.—(3) Axell, Om anordningarna för de fanerogama väx-

- ternas befruchtning 37, 64-5, 98. 1869. *L. coerulea*.—(4) Ricca, Osservazioni sulla fecondazione incrociata dei vegetali alpini e subalpini. Atti Soc. Ital. Sci. 14:255-6. 1871. *L. nigra, xylosteum, coerulea*.—(5) Müller, Befruchtung der Blumen 361-4. 1873. *L. periclymenum, caprifolium, tatarica, xylosteum*.—(6) White, The influence of insect agency on the distribution of plants. Am. Nat. 7:271. 1873. *L. periclymenum*. (Just 1:377.)—(7) Delpino, Ulteriori osservazioni II. 2:44, 114, 179, 276, 336; Atti Soc. Ital. Sci. 16:192, 262, 327. 1873; 17:—. 1874. *L. caprifolium, coerulea, xylosteum, periclymenum, longiflora, sempervirens*. (Just 2:893.)—(8) Lubbock, British wild flowers in relation to insects 108-10. 1875. *L. caprifolium, periclymenum, xylosteum*.—(9) Gray, Darwin on the effects of cross and self-fertilization in the vegetable kingdom. Am. Journ. Sci. & Arts III. 13:133. 1877. (Just 5:743.)—(10) Bonnier, Les Nectaires. Ann. Sci. Nat. Bot. VI. 8:72, 86, 138-9, 187, 192. 1878. *L. fragrantissima, periclymenum, sempervirens, standeskii*.—(11) Errera et Gevaert, Sur la structure et les modes de fécondation des fleurs. Bull. Soc. Bot. Belgique 17:106. 1878. *L. caprifolium*.—(12) Dodel-Port, Die Liebe der Blumen. Illustr. Pflanzenleben Lief. 4/5:185-240. 1880. *L. periclymenum*. (Just 8:183.)—(13) Gray, Structural Botany 217. 1880. *L. sempervirens*, ornithophilous.—(14) Müller, Die Entwicklung der Blumenthätigkeit der Insekten. Kosmos 9:272. 1881. *L. alpigena*. (Just 8:148.)—(15) Müller, Alpenblumen 394-9. 1881. *L. nigra, alpigena, coerulea*. (Just 7:102.)—(16) Dufour, Existence de tensions chez certaines fleurs 42-6. Dissertation inaug. Lausanne. 1882. *L. ledebouri*. (Just 9:500.)—(17) Müller, Weitere Beobachtungen 3:75. 1882. *L. periclymenum*. (Just 9:526.)—(18) Müller, Fertilization of Flowers 293-9. 1883. *L. coerulea, periclymenum, caprifolium, tatarica, nigra, xylosteum, alpigena*.—(19) Focke, Nägeli's Einwände gegen die Blumentheorie, erläutert an den Nachtfalterblumen. Kosmos 14:299. 1884. *L. caprifolium, periclymenum*. (Just 12:668.)—(20) Loew, Blumenbesuch von Insekten an Freilandpflanzen. Jahrbuch Bot. Gartens Berlin 3:78, 90. 1884; 4:98-9. 1886. *L. caprifolium, periclymenum, alpigena*.—(21) Ingen, Bees mutilating flowers. Bot. Gaz. 12:229. 1887. *L. parviflora, grata*. (Just 15:413-4.)—(22) Meehan, Adaptation in the honeysuckle and insect visitors. Bot. Gaz. 13:237-8. 1888. (Just 16:555.)—(23) Meehan, Contributions to the life histories of plants. II. Proc. Acad. Nat. Sci. Phila. 1888:279-83. *L. japonica*. (Just 16:538.)—(24) Meehan, Adaptation in the honeysuckle and insect visitors. Proc. Am. A. A. S. 1888:284. (Just 17:548.)—(25) Noll, Ueber die normale Stellung zygomorpher Blüten und ihre Orientirungsbewegungen. Arbeiten Bot. Institut Würzburg 3:189-252. 1888. (Just 13:752.)—(26) Pammel, On the pollination of *Phlomis tuberosa* and the perforation of flowers. Trans. St. L. Acad. Sci. 5:254, 275. 1888. *L. caprifolium, flava, glauca, grata, sempervirens*, perforation.—(27) Schneck, Mutilation of flowers by insects. Bot. Gaz. 13:39. 1888. *L. sempervirens*.

(Just 16<sup>1</sup>:538.)—(28) Kirchner, Beiträge zur Biologie der Blüten. Progr. 72 Jahresfeier K. Württemb. landwirtschaftl. Acad. Hohenheim 62. 1890. *L. caprifolium, iberica*. (Just 18<sup>1</sup>:495.)—(29) Schultz, Beiträge zur Kenntniss der Bestäubungseinrichtungen und Geschlechtsvertheilung bei den Pflamen 2:95-6. 1890. *L. alpigena*. (Just 18<sup>1</sup>:519.)—(30) Fritsch, Caprifoliaceae Engler u. Prantl, Die nat. Pflanzenfamilien IV. 4:159. 1891. (Just 19<sup>1</sup>:409.)—(31) Kerner, Pflanzenleben 2:—. 1891; Oliver translation 2:—. 1895. *L. alpigena, caprifolium, etrusca, grata, implexa, nigra, periclymenum, xylosteum*. (Just 17<sup>1</sup>:531; 18<sup>1</sup>:485.)—(32) Heinsius, Over de bestuiving van bloemen der Nederlandsche flora door insecten. Bot. Jaarboek 4:115-16. 1892. *L. periclymenum*. (Just 20<sup>1</sup>:484.)—(33) MacLeod, Bevruchting der bloemen van Vlaanderen. Bot. Jaarboek 5:390. 1893; 6:373. 1894. *L. caprifolium, periclymenum*.—(34) Hancock, Ornithophilous pollination. Ann. Nat. 28:679. 1894. *L. sempervirens*.—(35) Loew, Blütenbiologische Floristik 26, 42, 147, 249-50. 1894. *L. alpigena, coerulea, caprifolium, iberica, periclymenum, xylosteum*.—(36) Meehan, Contributions to the life histories of plants. XI. Proc. Acad. Sci. Phila. 1894:169-71. *L. japonica*. (Just 22<sup>1</sup>:285.)—(37) Knuth, Blumen und Insekten auf den nordfriesischen Inseln 80, 156, 193. 1894. *L. periclymenum*.—(38) Knuth, Nachuntersuchung der Blüteneinrichtung von *Lonicera periclymenum* L. Bot. Centralblatt 60:41-4. (Just 22<sup>1</sup>:278.)—Knuth, Weitere Beobachtungen über Blumen und Insekten auf den nordfriesischen Inseln. Schr. Nat. Ver. Schleswig-Holstein 10:234-5, 254, 256. 1895. *L. periclymenum, tatarica*.—(40) Willis and Burkill, Flowers and insects in Great Britain. Ann. Bot. 9:240. 1895. *L. periclymenum*.

HELIANTHUS DIVARICATUS L.—The following visitors were observed on August 8, 14, 17, 21, 24, 27, 29, 31, and September 2, 4, 7, and 10:

Bees—*Apidae*: (1) *Bombus americanorum* F. ♂, s.; (2) *B. scutellaris* Cr. ♀, s. & c. p.; (3) *B. separatus* Cr. ♂, s.; (4) *Melissodes obliqua* Say ♀, s. & c. p., freq.; (5) *M. coloradensis* Cr. ♂ ♀, s. & c. p., freq.; (6) *M. americana* Lep. ♂ ♀, s. & c. p., freq.; (7) *M. nivea* Rob. ♂, s., freq.; (8) *M. pennsylvanica* Lep. ♀, s. & c. p.; (9) *M. simillima* Rob. ♂, s.; (10) *M. aurigena* Cr. ♂, s.; (11) *Megachile mendica* Cr. ♂, s.; (12) *M. optiva* Cr. ♀, s.; (13) *Coelioxys totonaca* Cr. ♀, s.; (14) *C. 8-dentata* Say ♂, s.; (15) *C. sayi* Rob. ♂, s.; (16) *Epeolus concavus* Cr. ♀, s.; (17) *E. lunatus* Say ♀, s.; (18) *E. donatus* Sm. ♂ ♀, s., freq.; (19) *E. compactus* Cr. ♂, s., freq.; (20) *E. pusillus* Cr. ♂, s.; (21) *E. nevadensis* Cr. ♀, s.; (22) *E. cressonii* Rob. ♂ ♀, s.; (23) *Panurginus labrosiformis* Rob. ♀, s. & c. p.; (24) *P. rugosus* Rob. ♀, s. & c. p.; (25) *Halictoides marginatus* Cr. ♂ ♀, s. & c. p., freq.; *Andrenidae*: (26) *Halictus pectoralis* Sm. ♀, c. p., freq.; (27) *H. ligatus* Say ♂ ♀, s. & c. p., freq.; (28) *Augochlora confusa*



Rob. ♂ ♀, s. & c. p.; (29) *Colletes americanus* Cr. ♂ ♀, s.; (30) *Andrena helianthi* Rob. ♂, s.; (31) *A. pulchella* Rob. ♀, s. & c. p.

Diptera—*Bombylidae*: (32) *Exoprosopa decora* Lw.; (33) *Anthrax palliata* Lw.; (34) *A. halcyon* Say; (35) *Sparnopolius fulvus* Wd., ab.; (36) *Systoechus vulgaris* Lw.; *Conopidae*: (37) *Zodion fulvifrons* Say, freq.; (38) *Z. nanellum* Lw.; *Syrphidae*: (39) *Eristalis transversus* Wd.; *Anthomyidae*: (40) *Proboscimyia siphonina* Bigot — all s.

Lepidoptera—*Rhopalocera*: (41) *Phyciodes nycteis* Db.-Hew.; (42) *Catopsilia eubule* L.; (43) *Colias philodice* Gdt.; (44) *Pamphila cernes* Edw. — all s.

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